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Dundee Discussion Papers in Economics

Aggregate and Disaggregate Analysis of the Effects of Government Expenditure on Growth

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AGGREGATE AND DISAGGREGATE ANALYSIS OF THE EFFECTS OF GOVERNMENT EXPENDITURE ON GROWTH

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This paper attempts to establish empirically whether different types of public spending are responsible for a decline in economic performance. Specifically, it investigates how total expenditure, and, in more details, government consumption and social security transfers, can affect productivity growth and, by consequence, the rate of growth of value added (VA). The first part of this work highlights the role of TFP in a country's growth and its correlation with government expenditure. The regressions examine whether public spending contribute to a country's growth through the marginal product of factors of production and their effects on TFP. Results vary considerably: with eleven manufacturing, total spending is significant and positively related to VA-growth, while the technological gap between countries appears insignificant. Adding to the analysis five services sectors, the outcome shows not significant correlation between government expenditure and growth performance. The second part includes a measure of openness calculated as the ratio of trade to GDP to test whether there is causal relationship between a country's welfare and the size of its public sector or both public spending and growth depend on openness independently, and the direct statistical correlation between them is spurious; however there is no statistics of spurious correlation.

JEL Classification: H5, I3, O4.

Keywords: Economic Growth, Government Expenditure, Total Factor Productivity.

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1. Introduction

This work investigates the effects of welfare state (WS) programs on the performance of an economy. Nowadays, the conventional belief is that the taxation required to finance public spending -WS policies in particular- has distortionary effects and leads to rigidities in the labour market, hence most industrial economies strive to 'roll-back' the WS as precondition for successful competition in the global economy.

The aim of this article is to contribute towards the empirical assessment of the robustness of this conventional wisdom, in order to identify the main mechanisms through which government policies affect a country's prosperity. I will enhance previous works in a number of ways: I include a measure of TFP instead of proxying it by labour productivity; I focus on the effects of total government expenditure and social security transfers (SS) and update the time span to 1996; I attempt to establish whether there is causal relationship between government size and growth by introducing openness variables.

On a theoretical ground, whilst some authors highlight the positive effects of WS on a country's economic performance due either to the role of public sector as risk insurer (Sinn, 1995; Rodrik, 1997 and 1998; Wildasin, 1995) or to its effects on a country's real income and competitiveness (Molana and Montagna, 2000, 2002, 2003; Atkinson, 1998; Devereux, Head and Lapham, 1996), others focus on the distortionary effects of public expenditure and taxation, harmful for competitiveness (Alesina and Perotti, 1997).

Even the empirical attempts to assess benefits or costs of government involvement have mixed results: some identify no significant relationship between WS spending and the rate of growth (Easterly and Rebelo, 1993; Mandoza, Milesi-Ferretti and Asea, 1997), while other find either a significant positive (Korpi, 1985; McCallum and Blais, 1987;

Castles and Dorwick, 1990; Sala-i-Martin, 1992) or negative relation between the variables (Barro, 1991; Weede, 1991; Engen and Skinner, 1992; Hansson and Henrekson, 1994; Grier, 1999; Fölster and Henrekson, 2001).

Section 2 outlines the model and describes the dataset used. Section 3 carries out the regressions'. Section 4 explains the role of openness variable, followed by the results found introducing openness variable to test a potential spurious correlation between public spending and growth. Section 5 draws the conclusions.

2. The Basic Model

In a previous work Hansson and Henrekson (1994) tested the effects of different kinds of government expenditure on productivity growth in the private sector.

I assume that each industry has a simple production function

$$(1) \quad Y_t = A_t f(K_t, L_t)$$

where t is time, Y is net output (or value added), K is capital, L is labour, f is the function capturing the underlying technology and A is the exogenous shift in technology representing TFP¹, and I examine the determinants of growth between $t=s$ and $t=\tau>s$.

Taking logarithms,

$$(2) \quad \log Y_t = \log A_t + \log f(K_t, L_t)$$

Letting $y=\log y$ and $a=\log A$,

$$(3) \quad (y_\tau - y_s) = (a_\tau - a_s) + [\log f(K_\tau, L_\tau) - \log f(K_s, L_s)]$$

¹ TFP is commonly defined as a ratio of a volume measure of output to a volume measure of input use; there are many different productivity measures of productivity; the choice between them depends on the purpose of the measurement and, in many instances, on the availability of data. This work will concentrate on a multifactor productivity measure based on a value-added concept of output

Using the approximation

$$(4) \quad \log f(K_\tau, L_\tau) = \log f(K_s, L_s) + (K_\tau - K_s) \left[\frac{\partial \log f(K_s, L_s)}{\partial K_s} \right] + (L_\tau - L_s) \left[\frac{\partial \log f(K_s, L_s)}{\partial L_s} \right]$$

I obtain

$$[\log f(K_\tau, L_\tau) - \log f(K_s, L_s)] = (K_\tau - K_s) \left[\frac{f'_{K_s}}{f(K_s, L_s)} \right] + (L_\tau - L_s) \left[\frac{f'_{L_s}}{f(K_s, L_s)} \right]$$

This can be rewritten as

$$[\log f(K_\tau, L_\tau) - \log f(K_s, L_s)] = (K_\tau - K_s) \left(\frac{MPK_s}{Y_s} \right) + (L_\tau - L_s) \left(\frac{MPL_s}{Y_s} \right)$$

Hence,

$$[\log f(K_\tau, L_\tau) - \log f(K_s, L_s)] = \left(\frac{MPK_s}{Y_s/K_s} \right) \left(\frac{K_\tau - K_s}{K_s} \right) + \left(\frac{MPL_s}{Y_s/L} \right) \left(\frac{L_\tau - L_s}{L_s} \right)$$

Substituting the expression on the right-hand-side of the latter in equation (3) and letting

\hat{a} on a variable denote its proportional rate of change, I have

$$(5) \quad \hat{Y}_\tau = \hat{A}_\tau + \kappa_s \hat{K}_\tau + \lambda_s \hat{L}_\tau$$

Where $\kappa_s = \left(\frac{MPK_s}{APK_s} \right)$ and $\lambda_s = \left(\frac{MPL_s}{APKL_s} \right)$ are the elasticities of output with respect to capital and labour, respectively.

Equation (5) describes the output growth for industry i in country j from year s to year τ .

Hence,

$$(5') \quad \hat{Y}_{ij,\tau} = \hat{A}_{ij,\tau} + \kappa_{ij,s} \hat{K}_{ij,\tau} + \lambda_{ij,s} \hat{L}_{ij,\tau}$$

Following Hansson and Henrekson (1994), I assume that \hat{A}, κ and λ are affected by government expenditure as follows

(6) $\hat{A}_{ij,\tau} = \alpha_0 + \alpha_1 \bar{g}_{j,\tau} + \alpha_2 \tilde{a}_{ij,\tau}$, which postulates that the growth rate of TFP depends on the share of public expenditure in the economy, \bar{g}_j , and on a catching-up factor that captures the extent of the initial technological gap, \tilde{a}_{ij} .

(7) $\kappa_{ij,s} = \kappa_0 + \kappa_1 \bar{g}_{j,s}$ and (8) $\lambda_{ij,s} = \lambda_0 + \lambda_1 \bar{g}_{ij,s}$, which allow the elasticity of production with respect to factors to be affected by the country's government expenditure, where $\bar{g}_{j,s}$ is the ratio of government expenditure to GDP in the relevant period.

Substituting (6), (7) and (8) into (5'), and reintroducing the time subscript, I have

$$(9) \quad \hat{Y}_{ij,\tau} = \beta_0 + \beta_1 \bar{g}_{j,\tau} + \beta_2 \tilde{a}_{ij,s} + \beta_3 \hat{K}_{ij,\tau} + \beta_4 \bar{g}_{j,s} \hat{K}_{ij,\tau} + \beta_5 \hat{L}_{ij,\tau} + \beta_6 \bar{g}_{j,s} \hat{L}_{ij,\tau} + u_{ij,\tau}$$

where β s are constant parameters – which depend on $(\alpha_0, \alpha_1, \alpha_2, \kappa_0, \kappa_1, \lambda_0, \lambda_1)$ – and the last term embodies any omissions and approximations introduced above. On the assumption that the latter is a well-behaved random disturbance term, I can estimate the above equation using data from a representative sample of industries in a number of countries (see Appendix 1 for information on dataset and estimations).

3. Results

Firstly I examine the effects of different components of public expenditure on GDP-growth, considering 11 manufacturing sectors (results in Table 1-end of paper).

The first regression is obtained from equation (9) by setting $\beta_1=\beta_4=\beta_6=0$,

$$\hat{Y}_{ij,\tau} = \beta_0 + \beta_2 \tilde{a}_{ij,s} + \beta_3 \hat{K}_{ij,\tau} + \beta_5 \hat{L}_{ij,\tau} + u_{ij,\tau}$$

and it investigates the relationship between a country's rate of growth, the marginal productivities of factors and TFP, proxing the latter by the mentioned catching-up factor that captures the extent of the initial technological gap, \tilde{a}_{ij} (See Appendix 2 for details). Contrary to the results achieved by the literature on economic convergence, our outcomes highlight the insignificance of the initial levels of TFP on a country's growth; at the same time, factors' marginal productivities turn out to be significant and have positive coefficients.

Subsequently, I drop the catching-up factor to test the robustness of the assumption that TFP is determined by the relevant government spending variable.

The second regression is obtained from equation (9) by setting $\beta_2=\beta_4=\beta_6=0$. Estimating

$$\hat{Y}_{ij,\tau} = \beta_0 + \beta_1 \bar{g}_{j,\tau} + \beta_3 \hat{K}_{ij,\tau} + \beta_5 \hat{L}_{ij,\tau} + u_{ij,\tau},$$

total government expenditure turns out to be significant and positively correlated to GDP-growth through its effects on TFP. Hence, the main theoretical assumption that drives our work clashes with the data analysed, and, since most growth models point to the role of differences in TFP in explaining differences in output and growth across countries, government spending seems to be a relevant source of TFP-differences. The marginal productivities of labour and capital are once again significant in this specification, and they will prove to be significant in all the following ones.

Studying the joint effects of both these variables (government expenditure and

technological gap) on TFP-growth $\hat{Y}_{ij,\tau} = \beta_0 + \beta_1 \bar{g}_{j,\tau} + \beta_2 \tilde{a}_{ij,s} + \beta_3 \hat{K}_{ij,\tau} + \beta_5 \hat{L}_{ij,\tau} + u_{ij,\tau},$

I achieve, once again, the predicted results.

Finally, the final regression², which coincides with equation (9),

$$\hat{Y}_{ij,\tau} = \beta_0 + \beta_1 \bar{g}_{j,\tau} + \beta_2 \tilde{a}_{ij,s} + \beta_3 \hat{K}_{ij,\tau} + \beta_4 \bar{g}_{j,s} \hat{K}_{ij,\tau} + \beta_5 \hat{L}_{ij,\tau} + \beta_6 \bar{g}_{j,s} \hat{L}_{ij,\tau} + u_{ij,\tau}$$

tests the more sophisticated hypothesis that government spending, in addition to its effects on TFP, may have an independent effect on the marginal productivity of factors, assuming that marginal productivities of labour and capital are linearly correlated with g . As expected, total public spending turns out to be significant when I consider its effects on productivity case and when I allow it to affect marginal productivity of labour. On the contrary the relation between government expenditure in 1970-1983 and marginal productivity of capital appears to be insignificant.

The results, therefore, are not consistent with Hansson and Henrekson's achievement of highly significant negative effect of total government expenditure on TFP-growth and insignificant relationship between public spending and marginal productivity of labour. They clash both the theoretical belief that government spending hurts capital productivity by destroying private savings, and Barro's idea of growth-supporting role of public spending by blocking the effects of decreasing marginal productivity of private capital (Barro, 1990).

At this point I attempt to shed light on the importance of government consumption and SS transfers on growth. Once again the impact of government spending emerges to be significant, and, in particular, SS transfers appear significant and positively correlated to growth.

Table 1 shows:

² The regression hypothesises that the average ratio of government expenditure to GDP over the period 1970-1983 affects marginal productivities of labour and capital, while TFP is affected by the level of public spending over the period 1983-1996.

1. Significant and positive effects of different components of public spending on TFP-growth, in particular SS transfers variable, that confirms the previous results.
2. Insignificant effects of the catching-up factor in any of the specifications. This highlights the role of productivity levels in 1983 of each industry and it stresses the idea that the initial technological level does not affect a country's growth path.
3. Significant negative effects of consumption and SS transfers on growth, through labour marginal productivity³.

It could be argued that government variables simply capture heterogeneity between countries and proxy country-specific characteristics which have not been included in the regression above; hence I drop the government variables, to avoid singularity problems, and introduce country dummies to obtain the following regression

$$\hat{Y}_{ij,\tau} = \beta_0 + \beta_2 \tilde{a}_{ij,s} + \beta_3 \hat{K}_{ij,\tau} + \beta_5 \hat{L}_{ij,\tau} + \beta_7 \text{countries} + u_{ij,\tau}.$$

Country dummies result insignificant (except for Japan⁴ and Sweden⁵), which confirms our previous outcomes and shows that government variables are not simply modelling the differences between countries.

Moreover, our results could be affected by sector specific fixed effects, hence I introduce sector dummies which replace the constant term and highlight the relevance of every single sector. The results confirm the existence of sector specific fixed effects

³ This last point confirms previous empirical works, such as McCallum and Blais (1987), whose results state that the level of SS payments (using an adjusted variable which removes the influence of demographic factors on pension payments) has played a significant role in economic growth.

⁴ Japanese economic growth fell markedly during the 90s in comparison to previous decades; especially in 1997-98, Japan experienced the most severe recession of any major industrial country in the post-war period.

⁵ Sweden belongs to the group of the 'Big Spenders' (shares of more than 50%) and its WS came under severe pressure in the early 90s with the country's deepest recession since the 30s. Both fiscal deficit and expenditure rose considerably. Lately the authorities' efforts to restore policy credibility, through a strong program of fiscal consolidation and by pursuing price stability in an inflation targeting framework, have been highly successful and the potential output in Sweden has grown at an estimated annual rate of 2.5% in recent years compared with 1.5% in the first half of the 1990s.

which I was not able to capture with the previous analysis. However, every sector dummy shows a significant correlation with our dependent variable which means that every sectors has relevant features which affect growth and the sector specifications are relevant in this kind of study.

I now extend the analysis to include agriculture and service sectors as well⁶, mainly because of the idea that the deindustrialization phenomena is one of the main reasons of growth of government size (Iversen and Cusack , 2000)⁷

Considering the whole economy the previous results are not confirmed: the technological catching-up factor remains insignificant but the government variables become insignificant in all specifications except the last one.

With R^2 equal to 0.6 in all the specifications, our regressors do not have a good explanatory power and the model does not capture properly the variables that affect growth. In specification IV R^2 increases slightly, which means that, when service sectors are taken into account, the effects of government expenditure on marginal productivity of capital become a more significant explanatory variable. In particular the rate of growth of GDP decreases when I allow government expenditure to affect capital productivity.

⁶ In the regression analysis, I actually focused on two intermediate steps as well and I have analysed an economy with “11 Manufacturing and Agriculture”, for which the results were similar to the first part of the study, and an economy made up of “11 Manufacturing and Service sectors”, for which the results appear to be consistent with the ones achieved in the case of a whole economy (Agriculture, 11 Manufacturing and Service).

⁷ According to Iversen and Cusack (2000), the growth of WS spending can largely be explained by the explosion of employment losses in traditional sectors, to which government has responded by promoting employment in private services, deregulating product and labour markets, allowing greater wage dispersion and using various forms of public insurance to compensate workers for the risks of having to find new jobs in services.

4. The effects of openness and trade policies on growth.

The previous paragraphs lead to the conclusion of a causal relationship between government size and growth, but they both may depend on a third variable independently and the direct statistical correlation between them may happen to be spurious⁸. Hence I have replaced government variables with openness variables to explain the growth performance and investigate whether there is casual relationship between government size and growth or not.

According to recent studies, once I investigate the connection between a country's openness to trade and its economic performance, I should expect a greater openness, as well as a greater total government expenditure, to lead to reductions in capital productivity.

However, running the regression

$$(13) \hat{Y}_{ij,\tau} = \beta_0 + \beta_1 \overline{op}_{j,\tau} + \beta_2 \tilde{a}_{ij,s} + \beta_3 \hat{K}_{ij,\tau} + \beta_4 \overline{op}_{j,s} \hat{K}_{ij,\tau} + \beta_5 \hat{L}_{ij,\tau} + \beta_6 \overline{op}_{j,s} \hat{L}_{ij,\tau} + u_{ij,\tau}$$

there is no significance of the explanatory variables (Column IV in Table 4) and this lead to the conclusion that the share of total trade in GDP does not affect a country's rate of growth, neither through TFP-growth nor through factors' marginal productivity.

⁸ On one hand, exposure to trade could affect growth affecting productivity of firms and industries; it could also increase the scope for an active role of the state as a provider of social insurance, by increasing the volatility of the economic environment (e.g. Rodrik, 1998). On the other hand, larger trade implies greater openness that facilitates the economy's adoption of more efficient techniques of production, leading to faster growth of TFP and, hence, real per capita income (Romer, 1992; Grossman and Helpman, 1991; Barro and Sala-i-Martin, 1995).

Columns V and VI check whether the stated correlation between public spending and growth could be spurious and could arise from the omission of other explanatory variables.

$$(14) \quad \hat{Y}_{ij,\tau} = \beta_0 + \beta_1 \overline{op}_{j,\tau} + \beta_2 \overline{g}_{j,\tau} + \beta_3 \tilde{a}_{ij,s} + \beta_4 \hat{K}_{ij,\tau} + \beta_5 \overline{op}_{j,s} \hat{K}_{ij,\tau} + \beta_6 \overline{g}_{j,s} \hat{K}_{ij,\tau} + \beta_7 \hat{L}_{ij,\tau} + \beta_8 \overline{g}_{j,s} \hat{L}_{ij,\tau} + \beta_9 \overline{op}_{j,s} \hat{L}_{ij,\tau} + u_{ij,\tau}$$

There is no evidence of spurious correlation: the coefficient of government spending remains statistically significant considering its effects on TFP-growth.

5. Conclusions

This paper attempts to prove empirically the effects of government expenditure on a country's economic performance, including a measure of TFP based on data on physical capital and labour, instead of proxing it by labour productivity.

Whether I consider total expenditure or its components, the average level of public spending in the period 1983-1996 has positive effects on the economy's rate of growth over the same period while the level of public outlays in the previous period (1970-1983) has a negative impact on growth through its effects on labour marginal productivity and the technological catching-up is always insignificant. Hence I can assert that government expenditure has a clear positive effect in the short and imminent period while it is not the same once we consider a longer time span. These results are further borne out when I investigate country and sector specific characteristics.

Finally, even testing the possibility of a spurious correlation between government size and growth due to their correlation with a measure of openness to trade, our results seem to be robust. I find no evidence of spurious correlation and the coefficient of government spending remains statistically significant.

Tables

Table 1. Basic model with aggregate government expenditure.

	<i>Aggregate Expenditure</i>				<i>Government Consumption</i>				<i>Social Security Transfers</i>			
<i>Variable</i>	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>
$\hat{K}_{ij,\tau}$	0.396 8.96	0.48 10.76	0.48 10.3	-0.002 -0.51	0.396 8.96	0.48 11.12	0.49 10.63	0.31 2.25	0.396 8.96	0.44 9.95	0.43 9.6	0.41 4.99
$\hat{L}_{ij,\tau}$	1.26 6.88	1.32 7.56	1.32 7.55	-0.06 -4.37	1.26 6.88	1.27 7.39	1.26 7.33	3.97 6.35	1.26 6.88	1.36 7.44	1.39 7.51	2.23 6.17
$\tilde{a}_{ij,s}$	0.001 0.077		0.006 0.44	-0.001 -0.95	0.001 0.077		-0.001 -0.68	-0.002 -1.43	0.001 0.077		0.001 1.05	-0.001 -0.32
$\bar{g}_{j,\tau}$		0.002 4.13	0.0017 4.14	0.001 2.29		0.004 4.62	0.004 4.66	0.002 1.81		0.003 2.64	0.003 2.84	0.005 3.03
$\bar{g}_{j,s} \hat{K}_{ij,\tau}$				-0.002 -0.51				-0.001 -0.02				-0.016 -2.03
$\bar{g}_{j,s} \hat{L}_{ij,\tau}$				-0.06 -4.4				-0.16 -4.68				-0.10 -3.13
C	0.003 0.25	-0.09 -3.85	-0.086 -3.54	-0.06 -2.04	0.003 0.25	-0.083 -4.24	-0.09 -3.95	-0.05 -1.7	0.003 0.25	-0.04 -2.33	-0.04 -2.07	-0.06 -2.50
R ²	0.79	0.81	0.81	0.85	0.79	0.81	0.81	0.85	0.79	0.80	0.80	0.84
N	154	154	154	154	154	154	154	154	154	154	154	154

Table 2. Model with country-dummies.

<i>Variable</i>	<i>I</i>	<i>II</i>	<i>III</i>
$\hat{K}_{ij,\tau}$	0.396 8.96	0.48 7.32	0.48 7.24
$\hat{L}_{ij,\tau}$	1.26 6.88	1.32 6.25	1.31 6.04
$\tilde{a}_{ij,s}$	0.001 0.077		-0.001 -0.16
JAPAN		-0.05 -3.28	-0.06 -2.29
SWEDEN		0.04 2.27	0.03 1.6
C	0.003 0.25		
R ²	0.79	0.84	0.84

In table 1 and 2 the dependent variable is GDP-growth over the period 1983-1996.

Table 3. Basic model with aggregate government expenditure, focus on Agriculture, Manufacturing and Services.

	<i>Aggregate Expenditure</i>				<i>Government Consumption</i>				<i>Social Security Transfers</i>			
<i>Var</i>	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>
$\hat{K}_{ij,\tau}$	0.36 8.65	0.40 8.38	0.39 8.29	0.70 5.91	0.36 8.65	0.39 8.64	0.39 8.39	0.69 5.11	0.36 8.65	0.37 8.23	0.37 8.21	0.60 7.18
$\hat{L}_{ij,\tau}$	0.55 5.53	0.56 5.61	0.56 5.59	0.46 1.68	0.55 5.53	0.56 5.61	0.56 5.59	0.67 2.07	0.55 5.53	0.56 5.56	0.56 5.56	0.46 2.54
$\tilde{a}_{ij,s}$	0.001 1.03		0.001 1.29	0.0001 0.09	0.001 1.03		0.0006 1.07	-0.001 -1.19	0.001 1.03		0.001 1.22	0.001 0.16
$\bar{g}_{j,\tau}$		0.001 1.30	0.001 1.51	0.001 3.31		0.001 1.31	0.0005 1.34	0.002 2.75		0.001 0.40	0.001 0.77	0.003 3.47
$\bar{g}_{j,s} \hat{K}_{ij,\tau}$				-0.009 -3.04				-0.02 -2.64				-0.02 -3.43
$\bar{g}_{j,s} \hat{L}_{ij,\tau}$				0.002 0.32				-0.73 -0.41				0.01 0.78
C	-0.01 -0.10	-0.02 -1.57	-0.017 -1.41	-0.06 -3.18	-0.001 -0.10	-0.02 -1.61	-0.01 -1.23	-0.04 -2.64	-0.001 -0.10	-0.72 -0.80	-0.01 -0.70	-0.04 -3.23
R²	0.59	0.59	0.59	0.62	0.59	0.59	0.59	0.61	0.59	0.59	0.59	0.62
N	221	221	221	221	221	221	221	221	221	221	221	221

Dependent variable: GDP-growth over the period 1987-1996.

Table 4. Model with openness variable.

<i>Variable</i>	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>V</i>	<i>VI</i>
$\hat{K}_{ij,\tau}$	0.21 3.90	0.22 3.99	0.22 3.81	0.21 3.06	0.26 4.53	-0.011 -0.05
$\hat{L}_{ij,\tau}$	0.74 4.40	0.75 4.14	0.75 4.08	0.79 2.23	0.83 4.57	1.92 1.63
$\sim a_{ij,s}$	-0.0002 -0.17		-0.0001 -0.12	-0.0001 -0.022	-0.0005 -0.37	-0.0007 -0.53
$\bar{g}_{j,\tau}$					0.001 2.96	0.0004 0.57
$\bar{op}_{j,\tau}$		0.031 0.23	0.03 0.18	0.0005 0.003	0.016 0.12	-0.02 -0.12
$\bar{g}_{j,s} \hat{K}_{ij,\tau}$						0.006 1.15
$\bar{op}_{j,s} \hat{K}_{ij,\tau}$				0.28 0.30		-0.14 -0.15
$\bar{g}_{j,s} \hat{L}_{ij,\tau}$						-0.025 -0.89
$\bar{op}_{j,s} \hat{L}_{ij,\tau}$				-0.75 -0.13		-0.99 -1.17
C	0.016 2.14	0.016 2.05	0.016 1.90	0.017 1.91	-0.05 -2.06	-0.009 -0.22
N	143	143	143	143	143	143

Dependent variable: GDP-growth from 1985 to 1992.

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Appendix 1. Data

All data concerning production, value added, labour compensation of employees, total employment and gross fixed capital formation come from the 2002 versions of *STAN Industrial Database*.

Government expenditure data comes from *OECD Historical Statistics 2000*. The government spending variables that I considered to be of interest are defined as follows: *Total Outlays* = Current disbursement + Gross capital formation, acquisition less disposals of non-produced non-financial assets and net capital transfers as a percentage of GDP; *Consumption* = Government final consumption expenditure as a percentage of GDP; *Social Security Transfers* = Social security benefits for sickness, old age, family allowances, etc., social assistance grants and unfunded employee welfare benefits paid by general government as a percentage of GDP. All these variables are related to GDP and the level is calculated as the average during the period under study.

The study covers, initially, 11 manufacturing industries (Food products, beverages and tobacco; Textiles, textile products, leather and footwear; Wood and products of wood and cork; Pulp, paper, paper products, printing and publishing; Chemical, rubber, plastics and fuel products; Other non-metallic mineral products; Basic metals, metal products, machinery and equipment; Basic metals and fabricated metal products; Machinery and equipment; Transport equipment; Manufacturing nec.) in 14 OECD countries (Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, Norway, Sweden, United Kingdom, United States) during the period 1970-1996. Afterwards I consider agriculture and 5 service sectors.

The first step of the regression, which enhances Hansson and Henrekson's analysis, is to calculate α and estimate equation (6) to obtain a measure of TFP. However, while data for Y , K , L , and g , are readily available for a number of OECD countries, I do not have a disaggregated measure of TFP to generate $\tilde{a}_{ij,s} = (a_{ij,s} - \bar{a}_{i,s})$. For each country j , $\tilde{a}_j = (a_j - \bar{a}_i)$ where for a sample of n countries $\bar{a}_i = \text{Maximum} \{a_{i1}, a_{i2}, \dots, a_{in}\}$, and \bar{g}_j is measured by the average over the period of the ratio of government expenditure to GDP. Hence, the catching-up is defined in terms of technological levels in different industries in 1983, contrary to most of the convergence theory that investigate differences in output or productivity over time.

Following Keller (1999) and assuming that the country's output is produced according to a Cobb-Douglas production function I can estimate the share of labour cost in production as $\alpha_{ij,s} = \frac{w_{ij,s} L_{ij,s}}{Y_{ij,s}}$ (where $w_{ij,s} L_{ij,s}$ is total labour compensation and $Y_{ij,s}$ is production).

All the data have been deflated using *OECD Historical series of PPPs for GDP* in order to have comparable measures. The OECD estimates are defined as the ratio of PPS for private final consumption expenditure to exchange rates; the Historical series are defined in terms of US dollars, hence the data used in my regression are all in terms of US dollars.

Afterwards, I run the multiple regression analysis which considers GDP-growth as dependent variable related to: a catching-up factor that captures the extent of the initial technological gap, $\tilde{a}_{ij,s}$; the growth rate of capital and labour, $\hat{K}_{ij,\tau}$ and $\hat{L}_{ij,\tau}$; the share of public expenditure in the economy averaged over the period 1983-1996, $\bar{g}_{j,\tau}$; and the elasticity of production with respect to factors, affected by the ratio of government expenditure to GDP averaged over the period 1970-1983, $\bar{g}_{j,s} \hat{L}_{ij,\tau}$ and $\bar{g}_{j,s} \hat{K}_{ij,\tau}$.

In all the regressions the growth rates and averages are calculated as follow:

$$\hat{x}_\tau = \frac{x_\tau - x_s}{x_s} \quad \bar{x}_\tau = \frac{\sum_s^\tau x}{(\tau - s + 1)}$$

$$\bar{x}_s = \frac{\sum_{1970}^s x}{(s - 1970 + 1)}$$

where $s=1983$, $\tau=1996$ and 1970 is the initial year. Hence the average over the period 1970-1983 of government expenditure to GDP is assumed to affect capital and labour productivity growth while the average over the period 1983-1996 of government expenditure to GDP is assumed to affect TFP.

Appendix 2. Estimation of Total Factor Productivity

In constructing the TFP variable, I consider data on physical capital and labour (there are no data on human capital by industry available). Data on labour inputs is taken from STAN database (number of workers engaged) that includes employees, self-employed, owner proprietors and unpaid family workers.

The physical capital stock is not available by sector, but I estimated it using data on gross fixed capital formation in current prices. Capital stock is estimated as follows:

$$k_{jt} = (1 - \hat{\delta}_j)k_{jt-1} + inv_{jt-1}$$

Where inv is gross fixed capital formation in constant prices and $\hat{\delta}$ is the rate of depreciation of capital. For the regression analysis, we assume that the level of capital stock at $t-1$ is equal to zero (due to lack of data on capital stock by sector) and we fix a constant depreciation rate $\hat{\delta} = 0.1$.

Assuming that the country's output is produced according to a Cobb-Douglas production function $Y = AL^\alpha K^{1-\alpha}$, α is the share of labour cost in production calculated as

$$\alpha_{ij} = \frac{W_{ij}}{Y_{ij}}$$

Where W_{ij} denotes labour compensation of employees (from STAN database) and Y_{ij} value added in current prices (again using sectoral output deflators).

Under the assumption of identical labour and capital elasticities each industry across countries, factor shares should be equal across countries. Hence, I have averaged labour share internationally in different sectors as measure of α_i and estimate TFP levels as

$$\log TFP_{ij} = \log Y_{ij} - \alpha_i \log L_{ij} - (1 - \alpha_i) \log K_{ij}$$

Where Y_{ij} is value added, L_{ij} is total employment and K_{ij} is capital stock in industry i and country j .

The catching-up factor is, therefore, the ratio of TFP level in the country with the highest productivity in industry i in 1985 over TFP level in industry i in country j .

Possible remarks could be done on the choice of the depreciation rate $\hat{\delta} = 0.1$ and capital at time $t-1$ equal to zero, nevertheless, imposing $k_{t-1} = 0$ is due to lack of data on

capital stock by sector while the choice of a 10% rate of depreciation is due to lack of data on country-specific depreciation rates (in Jorgenson and Landau (1993) we could find country-specific depreciation rates only for 8 of the 14 countries).